EC-Earth 3.0

Release Notes

Introduction

EC-EARTH v3 comes with major upgrades of it's component models: IFS cycle 36r4, NEMO 3.3.1, and OASIS3. Compared to their native versions, the model components have received few modifications, mostly for proper coupling. The default resolution is T255L91 in the atmosphere and ORCA1L46 in the ocean. Other configurations, both for higher and lower resolutions, are supported but have not been tested thoroughly.

EC-EARTH v3 has been successfully tested on a number of platforms, including ECMWF's supercomputers (`c1a`). Manuals for configuration, building, and running as well as access to the issue tracking system, discussion forums, etc. is provided via the EC-Earth 3 Development Portal at

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https://dev.ec-earth.org
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Note that access to the Development Portal is based on individual user accounts, which can be generated for EC-EARTH partners that have signed the Letter of Intent and an agreement with ECMWF. If you need to sign these documents, please contact `ecearth@ecmwf.int`. Once this is done, contact the Development Portals administrators (`uwe.fladrich@smhi.se` for the time being).

To get started with EC-EARTH v3, please refer to the Development Portal Wiki.

Notes on IFS

The recent developments from v2.3 regarding the use of pre-scribed forcings for CMIP5 have been included. As before, the CMIP5 forcings can be enabled with `LCMIP5=TRUE` in the IFS namelist and the RCP scenario is selected with `NRCP`. Please note that even though it is possible to change the namelist parameters manually, the recommend method of configuration has changed with the new release. Documentation of the new configuration tool (named `ec-conf`) is found both on the Development Portal and in the source code distribution. With `LCMIP5=TRUE`, pre-scribed values for solar forcing, volcanoes, greenhouse gases, aerosols and ozone are used. Changing land-use is not included (yet), EC-EARTH v3 currently uses climatological values.

Optionally, another namelist variable `NCMIP5FIXYR` can be added to the namelist. If `NCMIP5FIXYR` is set, it denotes the year from which the CMIP5 forcing will be taken (e.g. a pre-industrial run is done with `NCMIP5FIXYR=1850`).

IFS cy36r4 has no lake model and therefore lakes are not handled at all. To make the lake temperature and ice cover vary with time (annual cycle), the values are updated from the nearest ocean point (handled by OASIS).

The settings for the gravity wave drag parameterization have been adjusted following the recommendations of ECMWF's seasonal prediction group. The new settings yield a better climate in the stratosphere and in particular a more realistic QBO. These settings work only properly with T255L91, all other IFS configurations need a careful retuning. For more information see the corresponding Wiki pages at the Development Portal.

The treatment of snow that falls on ice sheets (glaciers, Greenland, Antarctica) has changed in v3. The accumulated snow is now removed from the ice sheets and added to the nearby ocean as ice, thus mimicking the calving of glaciers. Again, for more information see the corresponding Wiki pages at the Development Portal.

Notes on NEMO/LIM

The sea-ice model in v3 is LIM3 albeit LIM2 is still an selectable option. LIM3, even when run with a single sea-ice category, is a more sophisticated sea-ice model. In an experiment that compared EC-EARTH with LIM2 and LIM3 with a single sea-ice category, we found that the Arctic sea-ice extent and thickness look more realistic with LIM3.

LIM3 can be configured with multiple sea-ice categories. However, the multi category setup is not yet working well in coupled mode and until this problem is fixed we strongly recommend using only a single sea-ice category.

Notes on OASIS

OASIS is, by default, compiled and executed in pseudo-parallel mode. There are 21 coupling fields defined in the model; 15 fields are sent from the atmosphere to the ocean and 6 fields from the ocean to the atmosphere. Gaussian interpolation is used with 9 neighbours. The mismatch between the atmosphere's and the ocean's land-sea mask is handled by filling gaps from the nearest neighbour. All fluxes are globally conserved but not the state variables (e.g. SST).

The semi-Lagrangian advection scheme in IFS is not conserving mass. As a consequence we found that IFS produces water (P-E is positive on average) and the sea-level rises. To overcome this unphysical effect we apply a flux correction to the freshwater flux (runoff and calving) that is sent from the atmosphere to the ocean. More information about this is found on the Development Portal Wiki.

First results

The model configuration of the release has been tested in short experiments. Longer tests are under way and results are expected soon. The results from experiments with preliminary versions are accessible from Laurent's web site (`http://misu228.misu.su.se/ecev3`).

The following experiments illustrate how well EC-EARTH v3 is already doing. The AMWG diagnostics compares a 20-year slice of the model against observation (Note: not all variables are saved, some plots are empty, use with caution.)

- **Fixed Year 2000 Forcing** (experiment `w002`)
  - New settings for GWD parameterization
  - Snow on ice sheets is not handled
  - AMWG diagnostics:
    `http://misu228.misu.su.se/ecev3/amwg_diag5.5/w002-obs_2001-2020`
  - Ocean time series:
    `http://misu228.misu.su.se/ecev3/time_series/ocean/w002`
- **Fixed Year 2000 Forcing** (experiment `zc12`)
  - New treatment of snow
  - Default GWD parameterization
  - Flux correction for freshwater

    - AMWG diagnostics:
      `http://misu228.misu.su.se/ecev3/amwg_diag5.5/zc12-obs_2001-2020`
    - Ocean time series:
      `http://misu228.misu.su.se/ecev3/time_series/ocean/zc12`
- **Transient Forcing - For Comparison** (experiment `SHC1`)
    - The last 20 years of a historical CMIP5 run with v2.3
    - Model configuration T159L62-ORCA1L42
    - AMWG diagnostics:
      `http://misu228.misu.su.se/CMIP5/atmosphere/AMWG_DIAGS/SHC1-obs`
    - Ocean time series:
      `http://misu228.misu.su.se/CMIP5/ocean/SHC1`